MIT Invitational Tournament

Cell Biology Exam

ANSWER KEY

MIT Invitational Tournament 2015

Cell Biology ANSWER KEY

NAMES: **ANSWER KEY**	**TEAM ID**
SCHOOL:	

1. **1/2 pt for each row fully correct.**

Part	Plant	Animal	Prokaryote
(a)	x		x
(b)		x	x
(c)	x		
(d)		x	
(e)	x	x	
(f)	x	x	
(g)			x
(h)		x	
(i)	x	x	x
(j)	x		

2. **1 pt each**

A __2__ B __1__ C __3__

D __5__ E __4 or 6__ F __4 or 6__

3. **2 pts possible:**
1 pt for each valid reason

- May require chaperonin to fold properly
- May require certain subunit composition not met in vitro
- May require post translational modification which cannot be carried out in prokaryotic cells (anything about glycosylation, post translation cleavage, etc are acceptable

4. __B and E__ 1 pt for each correct choice. -1/2 pt for each extraneous choice

5. **1 pt each**

A __Nucleus__ B __Smooth ER__

C __Golgi__ D __Vacuole__

E __Rough ER__ F __Flagella/Cilia__

6. **SEE ATTACHED SHEET**

Scoring: 1 pt for each compound on the main path (c,d,g,l,m,n)
½ pt for each compound off the path (a,b,e,f,h,i,j,k)

7.

A __2__ B __2__ C __0__

D __0__ E __2__

8.

A __2__ B __8__ C __2__

D __6__ E __0__

9. C 10. B 11. D 12. ABD

13.

A __(Photosystem) II__ B __Plastoquinone__

C __(Cytochrome) b6f__ D __Plastocyanin__

E __(Photosystem) I__ F __NADPH__

14. **TIEBREAK**

A. Cyclic: electrons flow repeatedly through Photosystem 1 and cytochrome b6f. They do not react to form NADPH.
Noncyclic: Flow through both Photosystem I and II: do react with NADPH. (1pt)

B. Need to generate a greater ratio of ATP to NADPH than noncyclic flow can provide. (1pt)

C. NADPH is a source of *reducing electrons/reductive power.* (1pt)
ATP is a source of free energy but is *not* a reducing agent. (1pt)

D. Ribulose 1,5 Bisphosphate Carboxylase/ Oxygenase (DO NOT ACCEPT "RUBISCO")

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15.

A _PEP Carboxylase_ B __Malate___

C _____CO_2_____ D _Calvin Cycle_

16.

TIEBREAK 2 pts each

A. Photorespiration (1pt)/ high affinity for oxygen (1pt). RuBisCo can also use oxygen as a substrate instead of CO_2, energy is wasted on unproductive fixation of oxygen.: when this occurs, energy must be spent to restore the ribulose.

B. Uses PEP Carboxylase to perform initial fixation (1pt – don't have to explicitly mention PEP carboxylase, but explain that initial fixation is carried out by an enzyme with less affinity for oxygen.)
Releases CO2 in a controlled environment to boost CO2 levels for RuBisCo (1pt)

C. CAM metabolism (1pt)
CO2 fixed into organic acids at night and released during day for Calvin cycle. (1pt)

17.

A-H ½ pt each, I-K 1 pt each

A ___Cristae_____ B Outer Membrane

C ___Matrix__ D Intermembrane Space

E Inner Membrane F __Stroma_____

G ___Thylakoid__ H __Granum_____

*E and A are interchangeable

I. Mitochondria: Intermembrane space
Chloroplase: Thylakoid [Lumen]

J. Starch granules

K. Endosymbiosis

L. (2 pts max: 1 pt for any of):
Similar transport proteins to bacteria
Reproduce by binary fission
Partly independent genomes (similar in structure to bacteria—plasmids)
Ribosomes are similar to bacteria
Chloroplast internal structure is closely related to cyanobacteria

18.

A. 1 pt for correct answer.
1 pt for work that shows understanding

26.5g CO2 = .602 mol -> .1 mol glucose = 18.0g

18.

B. 1 pt for correct answer.
1 pt for work that shows understanding

Total energy:
4*2*1000*3600 = 28,800,000 Joules
Total energy converted:
26.5 g CO2 * 10,800 = 286,200 Joules

Efficiency ≈ 0.01 or 1%

2 pts each for 19 and 20

19. ___D___ **20.** ____Histidine___

21.

1 pt each

A. Starch has α 1-4 glycosidic bonds. Cellulose has β 1-4 bonds, which our enzymes are incapable of digesting.

B. Energy storage

C. Starch

D. Chitin

22.

TIEBREAK
(1/2 pt correct answer, ½ pt explanation)

A. 4: Many positive side chains to interact with the negative DNA molecule

B. 3: All nonpolar side chains that are stable in the hydrophobic environment inside the plasma membrane.

C. 1: Only chain with no proline or glycine residues, both of which heavily destabilize alpha helices.

D. Many negatively charged side chains to bind positive cations.

23.

½ pt each

A ___Prophase___ B ___Telophase___

C ___Anaphase_ D ___Metaphase_

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24.

1 pt each

A. Metaphase

B. Sister chromatids cannot separate, so the chromosomes are stuck on the equator.

25.

1 pt for correct consequence, 1 pt for correct reasoning

Uncontrolled cell growth and replication, since cyclin levels remain high and CDKs are constitutively active.

26.

½ pt each

A __1 billion_____

B __2 billion_____

C __0.5 billion____

27.

1 pt each (A and B can be switched)_

A _Techoic Acid__ B Lipotechoic Acid

C _Peptidoglycan_ D Cell Membrane

28.

½ pt for each component present

½ pt for each component in the right place

-1/2 pt for each extra component

From outside to inside

- Lipopolysaccharides
- Outer cell membrane
- Peptidoglycan/periplasmic space
- Inner cell membrane

29.

1 pt each

A. Phospholipids

B. Ampipathic: head is polar and tail is nonpolar

C. Van Der Waals / hydrophobic interactions

D. Allows greater membrane fluidity by disrupting interactions between saturated phospholipid tails.

30. **ACD**

31.

0.5 pts each

A. Active

B. Hydrolysis of ATP

C. Na^+ K^+ [Opt: Cl^{--}]

32.

TIEBREAK (2 pts)

Cl^- is retained in the cytosol since the transporter is broken. To counterbalance the charge Na^+ is also retained. This makes the cytosol hypertonic and causes the cells to retain water. This retention of water makes the mucus thicker than usual.

33.

0.5 pts each

A __2___ B __2___ C __3___

D __1___ E __1___ F __3___

G __1___ H __1___

34.

1 pt: 0.5 pts each property

- Decreases free energy of activation[speeds up reaction]
- Is not consumed in the reaction.

35.

1 pt each

A __T___ B __T___ C __F___

D __F___ E __F___ F __T___

36.

1 pt

B is the fastest. Lowest max activation energy along the pathway.

37.

TIEBREAK

2 pts each: 1pt right type, 1 pt explanation

A. Noncompetitive Inhibitor. V_{max} was is reduced compared to no inhibitor. (Accept allosteric if explanation correct)

B. Competitive Inhibitor. V_{max} is not affected, but the apparent K_m is different.

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38.

A. (1 pt) Any value from 10-15 uM is acceptable.

B. (3 pts) 1pt – count anywhere from 109 – 133 cells in the range.

1pt – calculate surface area of view area = $(100uM)^2 = 0.01\ mm^2$

1pt – Divide count by area in mm^2 to find density DROPPED DUE TO TYPO IN QUESTION

C. (1 pt) Surface area to volume ratio (or equivalent)

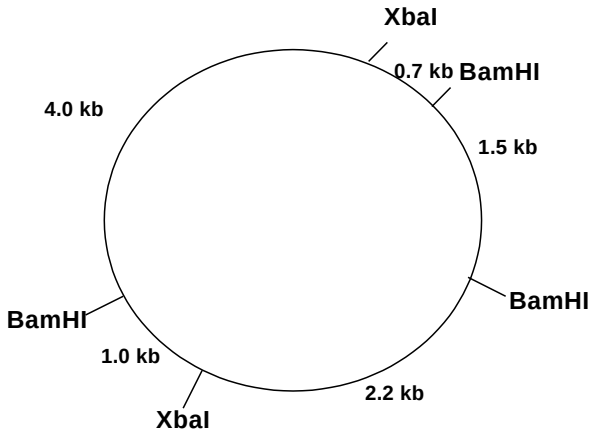
D. (1 pt) Eukaryotic

39.

TIEBREAK

A. (1pt) 9.4 kB

B. (2 pts): Complete correct plasmid is shown below.
B is only BamHI sites.



C. (2 pts) XbaI sites only

BONUS: (2 pts) Complete plasmid

Supplement: Glycolysis pathway